

Review Article

CHARACTERISTICS OF COCONUT COIR PITH AND ITS UTILIZATION IN AGRICULTURE

P. SAVITHRI and H. HAMEED KHAN¹
Department of Soil Science and Agricultural Chemistry
Tamil Nadu Agricultural University
Coimbatore 641 003, Tamil Nadu, India

ABSTRACT

Coir pith, a highly lignocellulosic material is available in large quantities as a by product of coconut coir industry. Coir pith contains lignin and cellulose in equal quantities. It has a surface area as high as 290 m² per gram and is rich in potash and micronutrients such as Fe, Mn, Zn and Cu. Studies to decompose coir pith were started considering the excellent physico-chemical characteristics of the material. *Pleurotus sajor-caju*, *Trichoderma* sp., and *Aspergillus* sp., were found to be potent degraders of coir pith. Technology on degrading coir pith with *P. sajor-caju* and *P. platypus* has been standardized to convert it as an agriculturally acceptable organic manure / amendment.

The potential of coir pith to improve the water holding capacity of soil, modify the physical and chemical properties of soil, and as an ameliorant in problem soils has been discussed. Beneficial effect of coir pith blended with inorganic fertilizers in many field crops viz. groundnut, maize, sorghum, turmeric, sunflower, rice and coconut has been established. There is scope for enriching coir pith with major and secondary nutrients for agricultural use. Indications are that if properly amended coir pith can serve as a substitute for farmyard manure, other organic manures and as a bedding material in poultry farms.

INTRODUCTION

India is one of the leading countries of the world in area and production of coconuts. During 1991-92 the estimated production was 10043.2 million nuts from an area of 1.52 million hectares. The area under coconut has been steadily increasing, particularly in the traditional coconut growing areas viz. Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and the Union territories of the southern peninsula. The increase in area and production was spectacular over the decade (Table I).

The husk, the shell and the copra are the useful products besides the leaves and stem which find their use in the daily life of the people of the coconut growing areas. Though the nut is considered to be the economic product, the other parts of the palm

are also economically used as such or as value added products.

The coconut husk finds its noble use due to its fibrous structure and resilience. After extracting the coir, the waste material

Table I. Area and production of coconut in southern states of India.

States	Area (000' ha)		Production (million nuts)	
	1980-81	1991-92	1980-81	1991-92
Andhra Pradesh	42.4	63.4	175.2	959.2
Karnataka	171.5	238.2	890.0	1225.3
Kerala	666.2	846.3	3036.4	4206.1
Tamil Nadu	116.0	240.3	1132.4	2755.8

Source: Directorate of Economics and Statistics,
Ministry of Agriculture and Irrigation,
Govt. of India.

¹Division of Crop Production, Central Plantation Crops Research Institute, Kasaragod 671 124, Kerala.

viz. the pith consisting of dust and bits of fibres of lesser length are considered waste and dumped on the road side in mounds and in increasing proportions every year. The tannins that ooze from the dump yards during monsoon are considered to create environmental pollution problems. Attempts were made by the Central Coir Board (India) to find better ways and means of utilization of this waste material. The abundant availability of coir pith in the southern states, the problems associated with its disposal, the associated environmental pollution problems and the physico-chemical characteristics of the material attracted the attention of agriculturists and technologists in finding productive use for this material.

According to Arumughan and Damodharan (1993) there are about 84,000 retting and coir extracting units in Kerala producing white fibre and about 650 brown coir units located in Tamil Nadu, Karnataka and Andhra Pradesh. Kamaraj (1993) reports that there are about 500 coir factories in Tamil Nadu for mechanical extraction of coir fibre. These small units produce considerable amount of coir pith which goes mainly unutilized. In Kerala also power extraction units which utilize the fresh husks have come into vogue for extraction of the brown fibre. Present indications are that this waste material can become an important source of organic matter and an important item of export besides the coir which is now used as geo-fabric material in western countries who are more concerned about the biodegradability of the material and environmental pollution.

The current boom in the fertilizer prices, farm energy requirements and the prevailing fuel shortage and growing preference for organically cultivated farm produce has necessitated the development of a programme for organic waste recycling in agriculture. This review is mainly attempted to draw the attention of farmers, extension workers, scientists as well as owners of coir industries

towards the use of coir pith in agriculture. The coir pith can find its use as an amendment in problem soils such as those with poor moisture retentivity, poor drainage and aeration, salinity, alkalinity, etc. It can serve if properly amended as a substitute for farm yard manure and other organic manures and as bedding material for poultry farms.

Coir pith and its composition:

The word coir is derived from 'Kayar' in Malayalam. Coir fibre is extracted from coconut husk - the mesocarp of the coconut fruit by two methods. The traditional method employed in India is extraction of fibre from coconut husk through retting in the coastal back waters where salinity and periodical flushing of the ret liquor are considered as pre-requisites. This traditional coir retting is practiced in most parts of Kerala and coastal areas of Tamil Nadu. The process consists of soaking the coconut husks in saline back waters for 4-12 months and after retting the fibres are separated by beating the retted husk with wooden mallets on logs or stones until the adhering pith is removed.

The pith material forming non fibrous tissues of the husk is generally referred to as coir pith and also coco-peat (Bhowmic and Debnath, 1985). This accounts for about 50-60 per cent of the total weight of the husk. The coconut husk is constituted by 70 per cent pith like material and 30 per cent fibre of which 12 per cent is considered as bristle fibre and 18 per cent as mattress fibre. During retting the fibrous mesocarp which is an assembly of individual fibres with cork like parenchymatous cells containing the cementing materials undergoes decomposition. A number of micro organisms play a vital biocatalytic activity in hydrolysing the pectin. Some of the tannins and polyphenolic compounds are also attacked. Since phenolic compounds at times inhibit the microbial activity, the concentration of which is kept low by simultaneous washings. Nagarajan (1983) has outlined the biochemical reactions and micro-organisms

involved in retting of coconut husks. In the other method the fresh unretted husk is used. The process consist of extraction of coir fibre using fibre extracting machines. In the traditional method of retting in back waters, much of coir pith is washed in back waters. By retting process the coconut husk yields a superior quality of fibre but, looses much of its nutrients. As early as 1923, Sampson observed that practically all the potash has been leached out (Table II) and it is probable that there has been a loss of phosphoric acid as well. However inspite of the anaerobic conditions, rapid denitrification has not been taking place in retting pits.

Therefore, the coir pith obtained from mechanical processing of unretted husk is richer in nutrients. It is also assessed that in India 7.5 million tons of coir pith is produced annually, (Kamaraj, 1994).

Coir pith consists mainly of ligno-cellulosic material free from any admixed heavy metals. Satyanarayana, *et al.* (1984) reported 37.1 per cent fixed carbon 0.04 to 0.2 per cent sulphur 1.28 per cent fats and resins and 7.1 per cent ash content in the coir-pith. The chemical composition of coir-pith as reported by Pillai and Warriier (1952) consists of 1.8 per cent fats and resins, 25.2 per cent lignin, 7.45 per cent pentosans and 35 per cent cellulose. The coir pith also holds 11.9 per cent moisture on

oven dry basis. Detailed analysis of coir-pith is given in Table III.

The composition of coir pith was found to vary depending upon the soils, viz. fertility status of the coconut gardens, method of extraction, disposal, time of collection and other environmental factors. The coir pith obtained from fully mature and older nuts contains higher amount of lignin and cellulose and lesser amount of water soluble salts compared to younger nuts. Appreciable variations in C:N ratio 112:1 (Nagarajan, *et al.* 1985) 60:1 and 58:1 (Ravichandran, 1988) and 104:1 (Theradimani and Marimuthu, 1993) has been reported.

Joachim (1930) from Ceylon (Sri Lanka) reported the manurial value of the dry dust obtained from unretted husk to be 0.9 per cent N, 0.05 per cent P_2O_5 , 0.9 per cent K_2O , 0.4 per cent Ca, 0.33 per cent lignin and 10.4 per cent pentosan. He observed that it decomposed slowly.

The pith material is found to be acidic in nature, though found to contain lower amount of salts and it is dependent on the quality of water used for retting. The bulk density is found to be very low because of high porosity coupled with low particle density. The unique property of this waste material is the high water holding capacity in the range of 400-600 per cent. Apart from this it is found to contain some amount of

Table II. Chemical composition of coconut husk and its products.

	Fresh coconut husk	Retted coconut husk	Cleaned coir	Dust obtained after beating out coir
<i>Calculated as dry weight</i>				
Nitrogen (%)	0.53	0.74	0.06	0.87
Ash (% by weight)	0.71	8.07	1.46	33.21
<i>Ash contents</i>				
Lime	0.33	0.37	0.39	0.55
Magnesia	0.21	0.57	0.16	0.59
Phosphoric acid	0.11	0.076	0.032	0.137
Potash	2.65	0.15	0.05	0.20
Silica	1.22	2.57	0.60	22.03

Table III. Chemical composition of coir pith

Bulk density (g/cm ³)	-	0.15
Particle density (g/cm ³)	-	0.49
Porosity (%)	-	76.7
Maximum water holding capacity (%)	-	624
Volume expansion 100 ml (%)	-	22.9
pH	-	5.8
Electrical conductivity mhos/cm	-	1.5
Lignin (%)	-	37.0
Organic carbon (%)	-	40.6
Nitrogen	-	0.68
C:N ratio	-	60.2:1
Total phenolic compounds mg/g	-	90.0
Total P(%)	-	0.026
Total K (%)	-	0.360
Total Ca (%)	-	0.80
Total Mg (%)	-	0.42
Total Manganese (ppm)	-	64.5
Total Fe (ppm)	-	1395
Total Zn (ppm)	-	80
Total Cu (ppm)	-	45.5

Source: Ravichandran (1988)

major secondary and micronutrients. The higher K content of the pith indicate the importance of this material and possibility of utilising this as a supplier of K to the

crops. The wider C:N ratio of 112:1 coupled with low N content, presence of soluble tannin related phenolic compounds (8-12%), its low and difficult bio-degradability are some of the problems associated with the direct application of coir-pith to the field crops (Fan *et al.* 1982). But its attractive moisture retention properties and availability in abundance draws attention for its large scale use as an organic manure. Pavithran (1993) reported that pith contains lignin and cellulose in almost equal amounts, i.e. 40-45 per cent. Fixing of sufficient amount of the active ingredient (pesticide and herbicide) may be possible if not as effectively as with pure cellulose or lignin due to its large surface area which is measured to be about 290 m²/g (Idiculla, 1983).

Structure of coir pith:

Coconut pith is an open cell foam as shown in scanning electron micrograph (Fig. 1). The cells are of almost uniform size and cylindrical in shape. The walls are very thin and empty cavities (lumen) are comparatively large. Average lumen size of the pith is about 50µm. (Pavithran, 1993).

Observation of broken cell walls stained

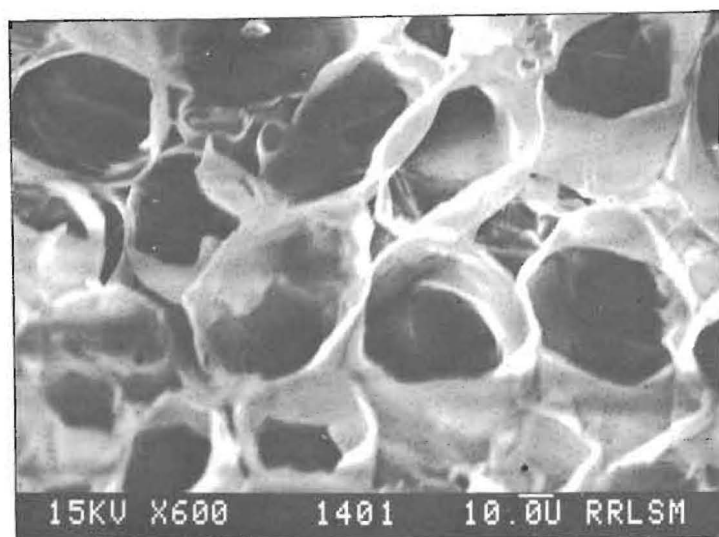


Fig. 1 Scanning electron micrograph of coconut pith

with Schulz's solution has shown that cellulose is seen to be in the form of thin fibrills as in the case of other ligno-cellulosic materials. Water sorption studies have shown existence of capillaries measuring 2 nm in the cell walls which contributes about 15 per cent of the total free space (Idiculla, 1983).

Composting of coir pith:

Any organic material having wider C:N ratio offer stiff resistance to microbial degradation which results in set back in the growth of crops temporarily (Smith and Elliott, 1990). Reduction of carbon and increase of N content resulting in narrowing down the C:N ratio is necessary before the organic material is applied to the soil. Among the several methods suggested for narrowing down the C:N ratio, composting has been found to be the most useful method with certain advantages. (Thambirajah and Kuthubutheen, 1989).

A study was conducted using 150 isolates of fungi isolated from the retting yards, coir industrial environment and known polymer depending types to screen them for their detoxifying effect in the phenolics and reduce the bulk of the coir dust. It was inferred that few of the laccase positive fungi expressed the capacity for the detoxification of phenolics by complexing them into brown complex. Some species of *Pleurotus* had the capacity to produce laccase and degraded part of the cellulose and lignin present in coir dust (Sesha Reddy, 1985) (Fig. 2, 2a). Besides laccase, a variety of biopolymer degrading enzymes were also released by this organism during growth on coir dust. Using radioisotopes some of the basic characteristics of coir dust degradation is established for *Pleurotus sajor-caju*. Apart from laccase enzyme component, three peroxidase positive proteins and two glucose oxidases were also produced. Cellulose and hemicellulose present in coir dust supported the initial growth of the fungus and these

two were the co-substrate for the lignin degradation.

A strain of *Streptomyces badins* was the most active lignin decomposing actinomycetes reported by Crawford and Sutherland (1979). Theradimani and Marimuthu (1993) studied the efficiency of many microbial species that are present in the coir pith in narrowing down the C:N ratio. *Aspergillus* sp, *Streptomyces* sp, *Penicillium* sp, *Trichoderma* sp and *Bacillus* sp were found to be the native microflora observed in the raw coir pith, partially composted and well composted coir pith (Table IV).

Trichoderma sp and *Aspergillus* sp were found to be the potent degraders as indicated by the low values of C:N ratio. An additional advantage associated with *Trichoderma* sp was its ability as a biocontrol agent of soil borne fungal diseases. In this context application of coir pith decomposed using *Trichoderma* sp. will be advantageous to obtain twin benefits of controlling *Ganoderma* sp. and improving the physical properties of the heavy soils in which coconut is cultivated in Andhra Pradesh.

To improve the manurial value of the coir waste, Nagarajan *et al.* (1985) tested few fertilisers in the decomposition process and urea addition was found to be more effective than addition of superphosphate and

Table IV. Microbial population of coir pith (CFU $\times 10^6$ g of dry coir pith) and C:N ratio.

Microbial organism	Raw coir pith	Microbial population	
		Partially composted coir pith	C:N ratio
<i>Streptomyces</i> sp.	13.3	18.0	80:1
<i>Aspergillus</i> sp.	8.0	10.6	31:1
<i>Penicillium</i> sp.	5.0	6.6	73:1
<i>Trichoderma</i> sp.	3.3	5.6	30:1
<i>Bacillus</i> sp.	11.0	19.0	63:1
Control	-	-	104:1

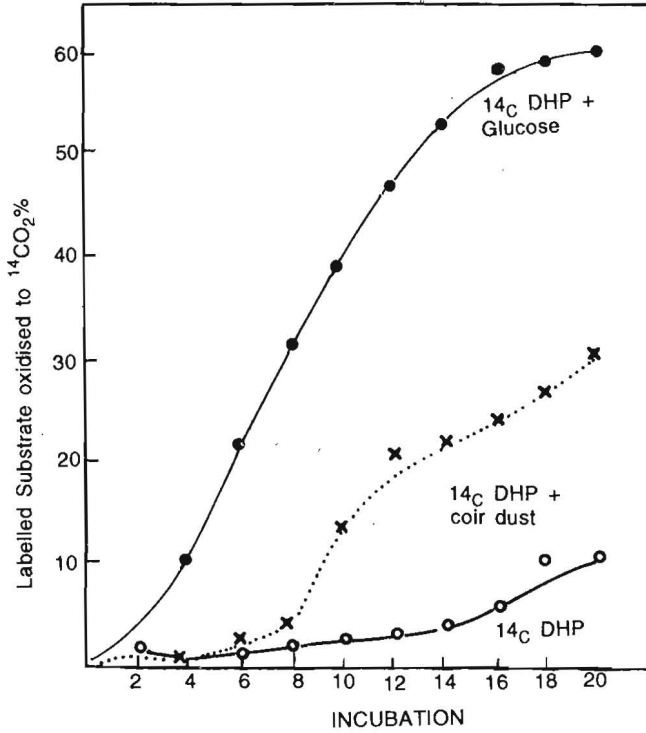


Fig. 2. Lignin (^{14}C -DHP) degradation by *Pleurotus*

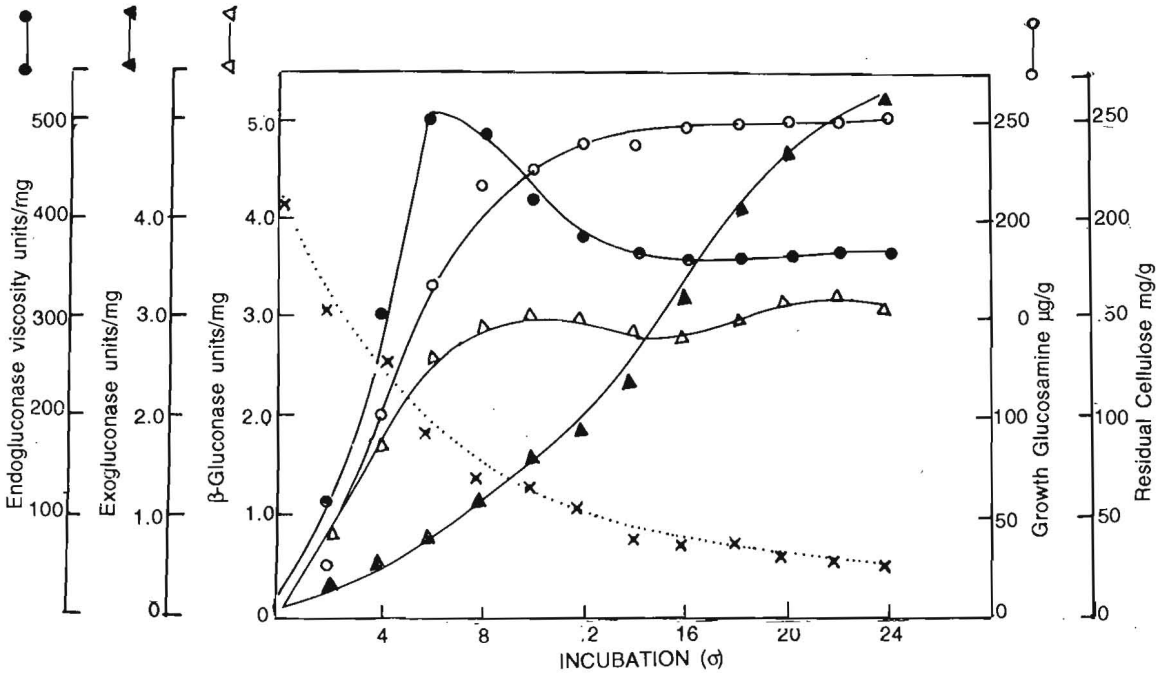


Fig. 2 a. Cellulolytic enzymes of *Pleurotus* during growth on coir pith

biogas slurry. The final methodology proposed is as follows:

Select an area of 5 m length and 3 m width in a shady place and spread 100 kg of coir pith approximately to a height of 2.0 cm. One bottle of spawn (300 g) of *Pleurotus sajor caju*/*Pleurotus platypus* is uniformly spread over the coir pith layer. Cover the layer with another 100 kg of coir pith. On the surface of this second layer one kg of urea is uniformly spread. This process of sandwiching the *Pleurotus* and urea alternatively with 100 kg coir is repeated until the heap reaches one metre height. For this process of composting of one ton of coir pith, five kg of urea and five spawn bottles (5 × 300g) are needed. The heap is periodically monitored to maintain the moisture content to about 200 per cent. This is achieved by sprinkling water. At the end of about 30 days the coir waste turns into a black/dark brown mass of compost. The chemical properties of composted coir pith and its comparison with undecomposed coir pith is presented in Table V.

Table V. Chemical composition of raw and composted coir pith

	Raw coir pith	Composted coir pith
Lignin (%)	30.0	4.8
Cellulose (%)	26.5	10.10
Organic carbon (%)	29.0	24.50
Nitrogen (%)	0.26	1.06
Phosphorus (%)	0.01	0.06
Potassium (%)	0.78	1.20
Calcium (%)	0.40	0.50
Magnesium (%)	0.36	0.48
Iron (%)	0.07	0.09
Manganese (ppm)	12.5	25.0
Zinc (ppm)	7.5	15.8
Copper (ppm)	3.1	6.2
C:N ratio	112:1	24:1
Volume	1.00m ³	0.52m ³

Rajendran (1991) evaluated six species of organisms viz: *Pleurotus sajor-caju*; *Trichoderma viride*, *Trichoderma mutant*, *Penicillium notatum*, *Fusarium coningii*,

Aspergillus niger, etc. under laboratory conditions. The C:N ratio obtained stressed the necessity of addition of urea for narrowing down the C:N ratio by way of increasing the N content of the material rather than reducing the carbon content. Besides *Pleurotus sajor-caju*, *Penicillium notatum* and the mixed culture of all the above six organisms were also reported to be effective along with the addition of 2.5 kg urea/ton of coir pith.

Enrichment of coir pith with P, Fe and Zn during the composting was also useful. Addition of rock phosphate to the acidic coir pith material favoured the availability of P, while addition of ZnSO₄ + FeSO₄ provided situations for the formation of natural organic complexes of Zn and Fe (Savithri and Rani Perumal 1993, Ramaswamy and Son, 1993).

Effect of coir pith on soil physical properties and soil-water retention:

The coir pith is fibrous in nature and this property improves the physical properties of even the heaviest clay soil and allow free drainage when pith is incorporated as an ameleorant. Because of its sponge like structure coir pith helps to retain water and improve aeration. Different physical properties of the soil viz. bulk density, pore space, infiltration rate and hydraulic conductivity were reported to be improved by coir pith application.

In a typical black soil (Typic chromustert) of southern Tamil Nadu, surface incorporation of coir pith @20 tons/ha to a depth of 15 cm improved the soil infiltration rate from 1.68 cm/hr. in the control plot to 6.75 cm/hr. in coir pith treated plots. The hydraulic conductivity of the soil was 2.3 cm/h in the control plot compared to 25.5 cm/ha in the coir pith treatment. In the other treatments it was 16.5, 21.5 and 6.4 cm/h such as pressmud, farm yard manure and sand respectively (Mayalagu, 1983). Usefulness of coir pith as a moisture conserving agent in rainfed agriculture has been reported

by Ramaswamy and Kothandaraman, (1991), Veerabadran, (1991), Rajendran, (1991).

The moisture content of the subsoil upto 60 cm depth was consistently higher in the coir waste mulch treatment in the cotton, and cotton + green gram cropping system (Rajendran, 1991).

Spreading of coir pith as mulch upto one meter radius to a thickness of 10 cm around the bole in coconut gardens was reported to conserve soil moisture for a very long time resulting in enhanced growth (Uthiah *et al.* 1993).

It is also reported that water holding capacity of the soil has increased by 40 per cent due to coir pith addition. (Brian, 1975).

Santhirasegaram (1965) opines that dry dust (coir pith-mechanically extracted using unretted husks) should be effective both in retaining moisture and as a source of other nutrients than the dust (pith) obtained from retted husks. Water holding capacity of cinnamon sands of Sri Lanka was increased in direct proportion to the amount of fibre dust incorporated into the soil. (Table VI).

Joachim (1930) observed that maximum water holding capacity of dry dust to be 82.3

per cent and when two per cent coir dust is added to sandy soil, it was increased to 40 per cent and the rate of drying is significantly decreased.

Liyanage (1988) reports that in coconut gardens coir dust can be buried instead of coconut husks as a moisture conservation practice. Maximum benefit can be obtained by burying coir dust in layers of 8 cm thick alternated with 5 cm thick soil layers. Experimental evidences from Coconut Research Institute, Sri Lanka have indicated that coir dust burying in coconut plantations in the dry and intermediate zones is a healthy management practice and in the gravelly soil it increased the yield of nuts by 20 per cent and copra yield by 15 per cent.

Coir pith for rainfed crops:

The productivity of drylands is decided by the interactive effect of many factors which mainly include adequate supply of soil moisture and soil fertility. Any attempt made to increase the soil moisture retention of rainfed lands should be immensely useful in increasing the production of different dry land crops. The use of coir pith is considered to be very useful for dryland crops as it serves more as moisture regulator

Table VI. Mean values for the number of days at 100 per cent field capacity (FC) and time taken to reach zero per cent field capacity in five soil: dust mixtures.

Treatment	Per cent coir dust added to soil	No. of days at 100% FC	No. of days to reach zero % FC
Without Plants	0.0	11	20
	12.5	16	24
	25.0	20	29
	37.5	24	32
	50.0	29	36
With Plants	0.0	1	6
	12.5	1	7
	25.0	1	8
	37.5	3	9
	50.0	6	13

and conservor rather than nutrient supplier. Inadvertently the K supply to the soil through coir pith might indirectly have its own role in plant water relationship.

In sandy soil coir waste application at 10 t/ha resulted in increased pod yield of peanut and realisation of higher cost-benefit ratio over mulching with sugarcane trash, groundnut husk, maize cob pith, pearl millet straw and non mulched control etc. (Arunachalam, 1987). Besides the above results, its usefulness in increasing the yield of number of crops viz. sorghum, pearl millet, finger millet, maize and cotton under rainfed condition to the tune of 10-30 per cent over control was reported by many (Anabayan, 1988; Athmanathan, 1988; Veerabadran, 1991)

Comparative efficacy of coir pith and farm yard manure:

In irrigated crops also the trend of results observed for number of crops revealed that the performance of coir pith is on par with that of FYM for rice, sorghum and

groundnut (Table VII).

However, the response of turmeric and sunflower, to coir pith application was better than farm yard manure. Promising results were obtained for the application of coir pith in sugarcane (Sundersingh *et al.* 1991), sunflower (Krishnamoorthy *et al.* 1991). Coir pith blended with NPK was effectively used in the establishment of coconut seedlings in littoral sandy soils (Quartzipsamments) (Table VIII). The effect of coir pith was far superior than control (NPK alone) and comparable with other treatments viz. coconut sheddings, forest leaves and farm yard manure in influencing plant characters and yield. (Anonymous, 1981)

Nambiar *et al.* (1983) observed that continuous application of coir dust for 8 years has influenced a reduction in bulk density, improved the water holding capacity and organic carbon status of the soil (Fig. 3) resulting in prococity in flowering of palms. For successful establishment of seedlings in coastal sandy soils organic

Table VII. *Comparative efficacy of coir pith and FYM on grain yield (t/ha.) different crops.*

Crop	NPK	NPK and FYM	NPK and coir pith	Reference
Sorghum	4.92	5.17 (4.8)	4.99 (4.42)	Savithri <i>et al.</i> (1991)
Turmeric*	108.0	136.8 (26.7)	161.7 (49.7)	Selvakumari <i>et al.</i> 1991
Rice	5.97	6.41	6.37	Selvi and Augustine Selvaseelan, 1991
Maize	4.73	5.67 (19.8)	5.54 (17.1)	Savithri <i>et al.</i> 1991
Groundnut	1.56	1.94 (24.4)	2.02 (29.5)	Nagarajan <i>et al.</i> 1989
Sunflower	1.59	1.62 (1.9)	1.84 (15.7)	- do -
Finger millet	3.69	4.98 (34.9)	4.53 (22.8)	- do -

*Rhizome yield

Figures in parentheses indicate the per cent increase in yeild over NPK.

Table VIII. Vegetative growth and yield of palms under different organic matter treatments (Year of planting 1971 - Reporting year 1981)

Treatment	No. of leaves produced	Height (cm)	Percentage flowering	Nut yield per palm
Coir dust + NPK	76	742	80 (24)*	15 (15)**
Coconut sheddings + NPK	76	739	71 (27)	6 (6)
Forest leaves + NPK	83	795	90 (27)	16 (18)
Cattle manure + NPK	82	705	84 (27)	14 (12)
NPK alone (control)	65	670	39 (7)	5 (2)

* No. of palms flowered ** No. of palms yielding.

supplementation is essential and coir pith can be an efficient source.

As early as 1914 Belfort and Hoyer reported that the refuse of the husks from coir factories is used by horticulturists to cover soil in carpet bedding as a protection to the bulbs from slugs, to pack between pots of cuttings and other similar purposes.

Use of coir pith for problem soils:

The tannery effluent with high electri-

cal conductivity ranging from 5-15 dS m⁻¹ and heavy load of heavy metals such as chromium is reported to pollute the soil as well as underground water with salts and heavy metals. Singaram and Pothiraj (1991) obtained significant response in maize and finger millet for the application of coir pith at 10 t/ha in the tannery effluent affected soils. The good response obtained for maize and finger millet might be due to effect of coir pith in adsorbing heavy metals and improving the leaching properties of soils.

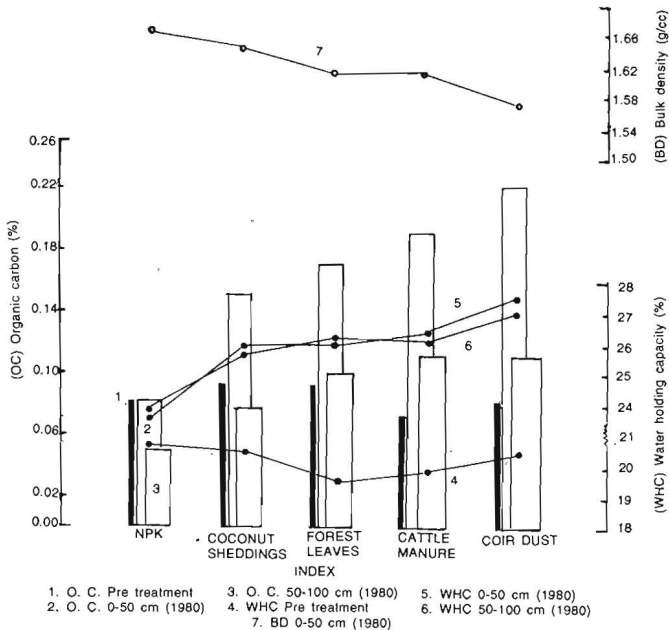


Fig. 3. Organic carbon, water holding capacity and bulk density as influenced by inorganic fertilizers and blended organic sources

Providing coir pith as mulch along furrows and ridges at 20 t/ha was effective in increasing the millable cane population, cane and sugar yield in the tannery effluent affected factory areas (Devaraj, 1991).

In a sodic soil (pH 10.1) application of composted coir pith, gypsum and fertiliser alone as well as in combination showed 35 per cent increase in grain yield for rice for the application of gypsum and coir pith at 10 t/ha over the treatment which received fertilisers alone (Fig. 4). As the coir pith is slightly acidic, it had additive effect with gypsum in lowering the pH of the soil (Fig. 5) alongwith an increase in exchangeable Ca and K content. The improvement in the physico-chemical properties was reflected on the nutrition of rice crop as reported by Savithri *et al.* (1991) (Fig. 6).

Clarson (1986) reported that application of coir pith (undecomposed) at 10 t/ha was found to aid in better management of saline

alkali soil (pH 9.2, EC 5.4 m. mhos/cm and ESP 62.79 m.e/100 g soil) for profitable rice production.

In an on-farm trial on groundnut in soils having a pH of 9.0, the application of gypsum at 400 kg alongwith 12.5 ton of composted coir pith/ha increased the pod yield appreciably (Ramamoorthy *et al.* 1991).

The occurrence of sub-soil hard pan often affect the yield potential of the crops by affecting the growth of the root system directly thereby limiting the absorption of water and nutrients. Incorporation of coir pith and chisel ploughing problem soils such as those having sub soil hard pan improved the hydraulic conductivity of different layers of soil (0-20, 20-40, 40-60 cm) and also the yield of pea nut (Gopalswamy *et al.* 1991)

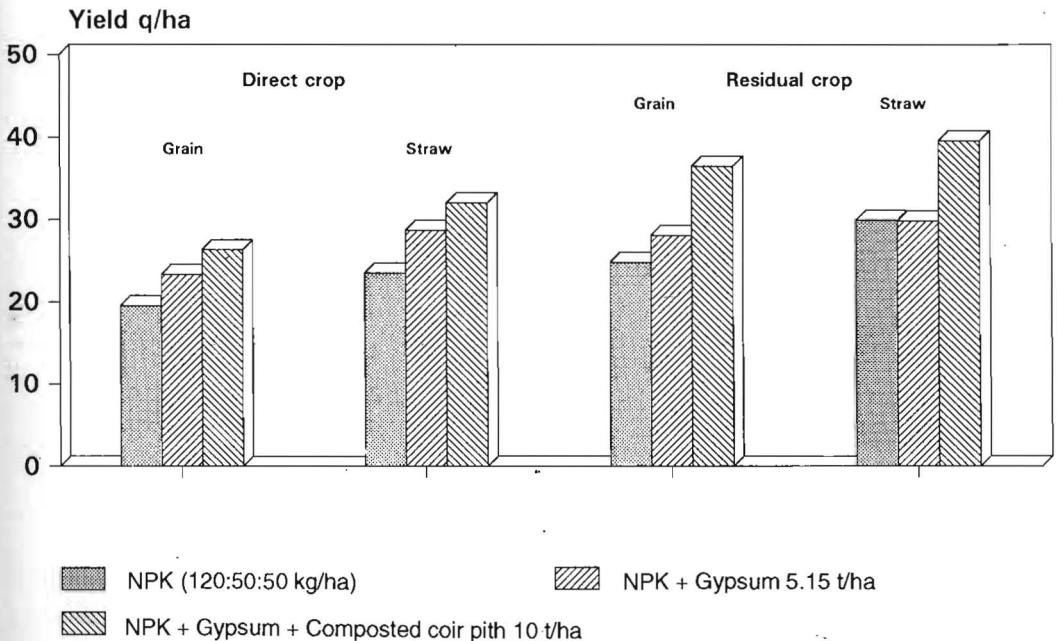


Fig. 4. Effect of gypsum + composted coir pith application on yield of rice in alkali soil

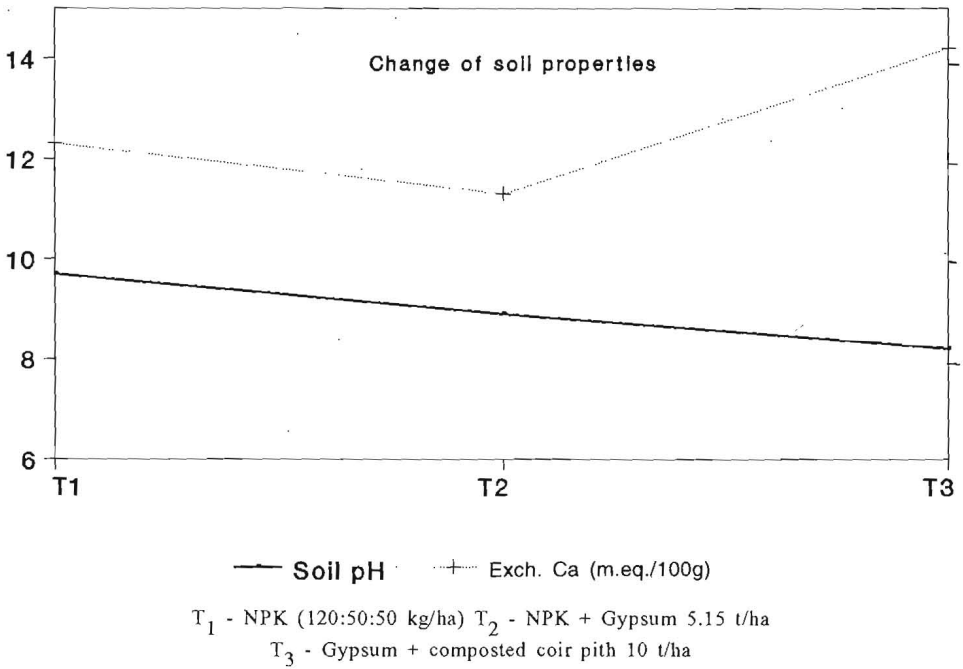


Fig. 5. Effect of gypsum + composted coir pith application on soil pH and exch. Ca in alkali soil

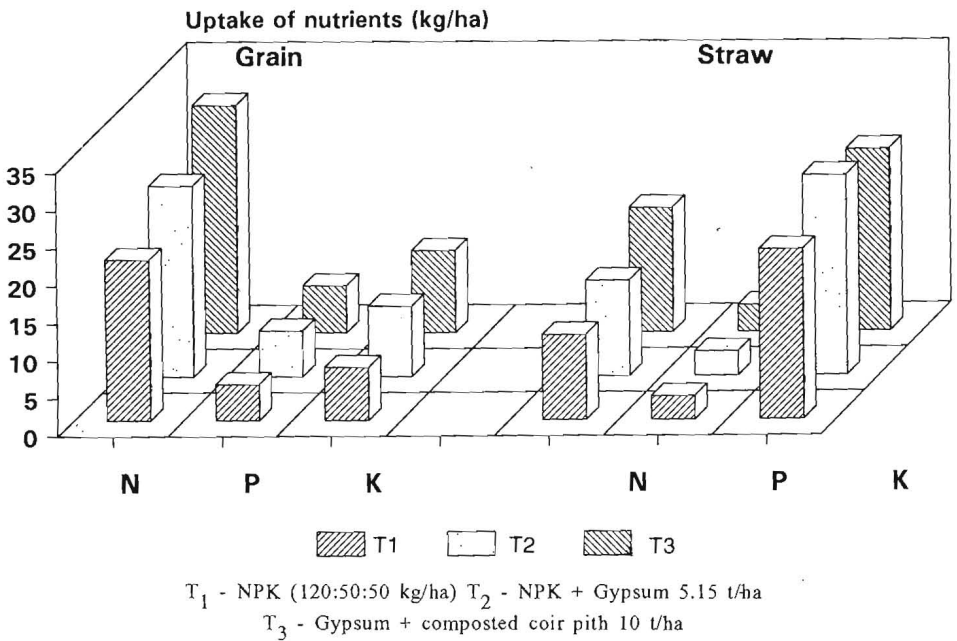


Fig. 6. Effect of gypsum + composted coir pith application on nutrient uptake by rice

Coir pith and economising potassium fertilisation:

As coir pith is found to contain an appreciable amount of potassium, attempts were made to use this as K source (Savithri *et al.* 1993). The results of irrigated maize and sorghum experiment conducted in vertisol soils having high K availability indicated that half the amount of recommended level of K applied with 12.5 t/ha of composted coir pith recorded yields which were at par with the yields obtained with full amount of potassium supplemented through composted coir pith. Similar results of savings of fertilizer potassium was also observed with finger millet under irrigated condition in red sandy loam soils of low K available status (Table IX).

Effect of continuous application of coir pith on soil properties and crops:

It is also important to ascertain the impact of continuous application of coir pith on soil properties and crops. In five field experiments with groundnut in red sandy loam soil (Typic Haplustalf) no appreciable change either in pH or in soluble salt content of the soil was noticed

(Nagarajan *et al.* 1991). The available N status of the soil did not vary significantly for coir pith treatments. But available potassium was increased by 80.7 per cent compared to the NPK treatment which is obviously due to high K content of coir pith. As regards the P availability in the soil, inspite of the low phosphorus in coir pith, the treatments which received coir pith showed higher values for available P content (50 kg/ha in T_2 and T_3 compared to 36 kg/ha in T_1) in the soil and higher crop yield with increased P uptake indicating the positive effect of coir pith in P transformation in the soil (Fig. 7).

Use coir pith based poultry litter:

The sun-dried coir pith can be safely used as bedding material for deep litter poultry farms. The coir pith gets enriched with nutrients due to the receipt of poultry droppings and can be directly used as manure for crops. It was observed by Savithri *et al.* (1991), Savithri and Rani Perumal (1993) that the coir pith based poultry litter addition either alone or in combination with fertiliser improved better the performance of sorghum, groundnut and sunflower in terms of yield (Fig. 8).

Table IX. Effect of composted coir pith on yield of maize, sorghum and finger millet (t/ha).

Treatments	Maize		Sorghum		Finger millet	
	Grain	Straw	Grain	Straw	Grain	Straw
Control	3.19	9.16	2.81	8.56	2.20	6.88
N, P ₂ O ₅ K ₂ O	4.73	11.60	4.53	13.65	3.69	10.07
N, P ₂ O ₅ K ₂ O + composted coir pith 12.5 t/ha	5.54	12.87	4.99	15.49	4.53	12.22
N, P ₂ O ₅ 50% K ₂ O + composted coir pith 12.5 t/ha	5.21	12.89	5.24	14.54	4.76	10.59
C.D.	0.49	0.55	0.28	0.75	0.45	0.46
N: P ₂ O ₅ : K ₂ O (kg/ha)	125:62:50		90:45:45		60:30:30	

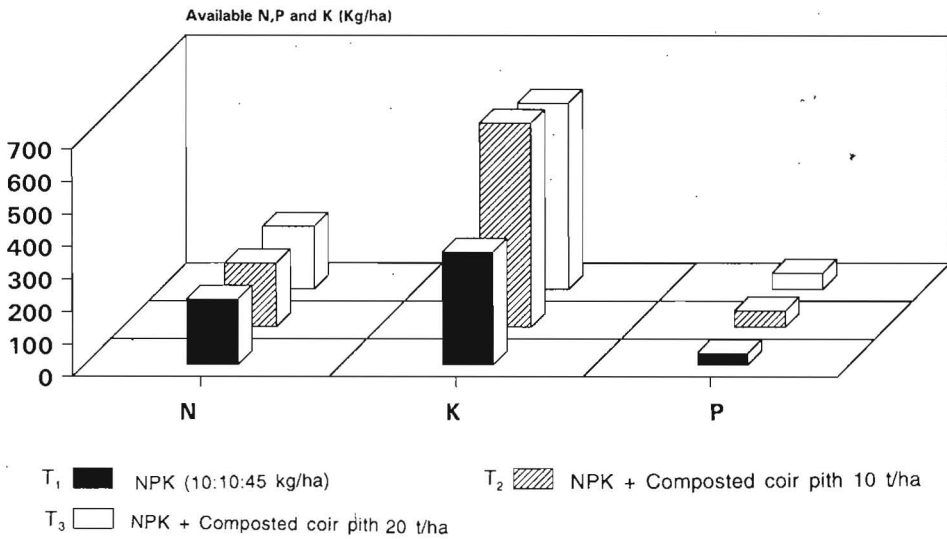


Fig. 7. Effect of continuous application of coir pith on nutrient availability in soil

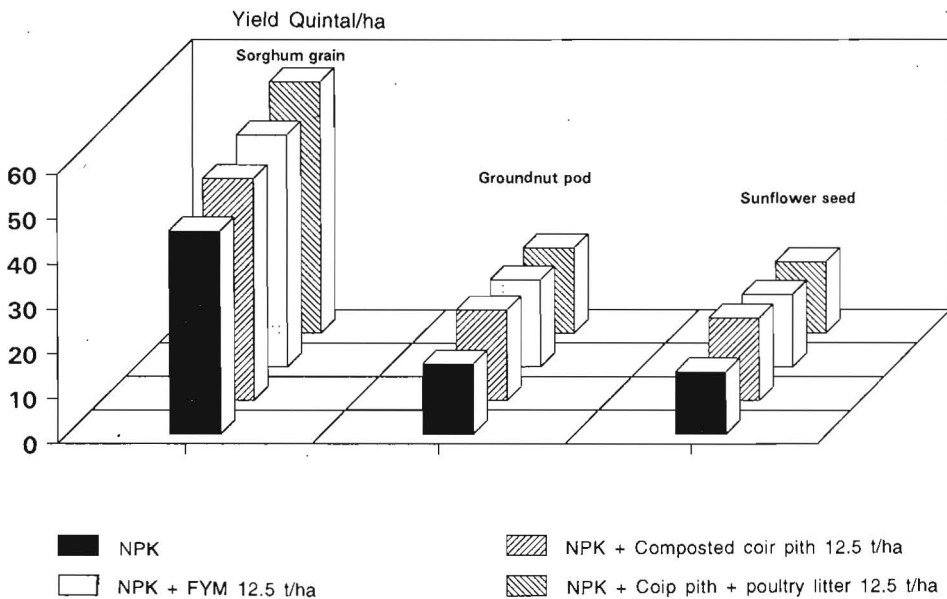


Fig. 8. Evaluation of coir pith based poultry litter as manure for crops

CONCLUSION

Usefulness of coir pith has been realised for a long time but the coconut cultivators were hesitant to use it as an organic manure due to its lignocelluloitic nature and resistance to decomposition. *Pleurotus sajor-caju* and a host of other fungi and bacteria have been identified as decomposers of coir pith. Technology has been developed using lignin degrading fungi viz. *P. sajor-caju* and *P. platypus* along with urea to render it as an agriculturally acceptable organic manure/ amendment. The problem of wide C/N ratio of undecomposed coir pith has been overcome by this process.

Usefulness of undecomposed coir pith blended with NPK fertilizers has been realised for the establishment of young coconut palms in littoral sands. Composted coir pith is successfully used for cultivation of annual crops and ameliorating problem soils.

Future studies should focus attention towards identifying efficient microbes other than *P. sajor-caju* and *P. platypus*

considering the difficulty in culturing and handling the same in the field. *Trichoderma* decomposed coir pith is advantageous in heavy soils. There is a need to understand the nature and extent of adsorption of nutrients by coir pith and its chelating properties if any. Continuous use of coir pith on the physical properties of soils has not been fully documented. The rate and extent of decomposition of composted and raw coir pith and accompanying changes in organic fractions and its interaction with soil types is another area of interest. There are indications that coir pith can be effective an affective substitute to farm yard manure if properly decomposed and used.

ACKNOWLEDGEMENT

The authors are thankful to Dr. M. K. Nair, Director, C.P.C.R.I. for all encouragement and to Dr. E. V. V. Bhaskara Rao, Project co-ordinator (Palms) for reading through the manuscript and offering suggestions.

REFERENCES

- ANABAYAN, K. 1988. Evaluation of enriched farm yard manure and coir compost for N and moisture management in rainfed sorghum. M.Sc. (Ag.) Thesis - Tamil Nadu Agricultural University, Coimbatore.
- ANONYMOUS, 1981. Central Plantation Crops Research Institute, 1983. Annual report 1981. Kasaragod, India.
- ARUNACHALAM, N. 1985. Coir waste increases groundnut yield. In : Workshop on Coir Research-paper presented. Coir Board, Cochin, Sep. 1985.
- ARUMUGHAN, C. and DAMODHARAN, A.D. 1993. Coconut based coir industry in India. In: *Advances in Coconut Research and Development* (Eds.) M. K. Nair et al. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India, pp. 633-640.
- ATHMANATHAN, V. 1988. Studies in production potential of groundnut in sole and intercropping systems under different management practices. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
- BELFORT, R. and HOYER, A. J. 1914. *All About Coconuts*. The St. Catherine Press, 34, Norfolk Street, W.C. 210 p.
- BHOWMIC, B. B. and DEBNATH, C. R. 1985. Coir Fibre, Part II. Potentiality of coir fibre products. *Indian Cocon J.* 16 : (3) 7-10.
- BRIAN, E. G. 1975. *Coconut Plant Products*. Food and Agricultural Organization of United Nations, Rome, pp. 142-143.

- CLARSON, D. 1986. Coir dust for economic reclamation of saline - alkali soils and for better profit. *Indian Cocon. J.* **16** (9) : 6-9.
- CRAWFORD, D. L. and SUTHERLAND, J. B. 1979. The role of actinomycetes in the decomposition of bignocellulose. *Dev. Indian Microbiol.* **29** : 1-14.
- DEVARAJ, G. 1991. Coir pith mulching to increase sugarcane yield in the tannery effluent affected soils. In: *Proceedings of seminar on 'Utilization of coir pith in agriculture'*. 20th Nov. 1991. Tamil Nadu Agricultural University, pp. 122-128.
- FAN, L. J., YOUNG - HYUN LEL and GHARPNAY M. M. 1982. The nature of lignocellulosics and their pre-treatments for enzymatic hydrolysis. *Adv. Biochem. Engg.* **23** : 157-187.
- GOPALASWAMY, A., RAJKANNAN, B., POONGOTHAI, S. and NATESAN, R. 1991. Efficacy of coir dust in comparison with pressmud and groundnut husks on physical properties of soils. In: *Proceedings of seminar on Utilization of coir pith in agriculture*, 20th Nov. 1991, Tamil Nadu Agricultural University, Coimbatore, pp. 151- 156.
- IDICULLA, R. 1983. Microstructure and water sorption mechanism of coconut pith. *J. Chem. Tech. Biotechnol.* **33** (A) : 439-445.
- JOACHIM, A. W. R. 1930. The fertilizer value and decomposability of coconut fibre dust. *Trop. Agric. (Ceylon)* **73**: 272-273.
- KAMARAJ, C. M. 1993. Use of coir pith as peat in commercial line and export opportunities. In: Workshop on utilization of coir pith - papers presented. 13 Feb. 1993. Coir Board, Govt. of India, Cochin, Kerala. 51p.
- KAMARAJ, C. M. 1994. Exportable coir products in Tamil Nadu. *The Coconut Wealth* **1** (6) : 6-8.
- KRISHNAMOORTHY, V. V., SUBRAMANIAN, K. S., SELVAKUMARI, G. and CHINNASWAMY, K. N. 1991. Influence of composted coir pith in red soil with sunflower. In: *Proceedings of Seminar on Utilization of coir pith in agriculture*. 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore, pp. 159-162.
- LIYANAGE, M. De. S. 1989. Use of coir dust for moisture conservation. *Cocon. Bull.* **5** (1) : 18-19.
- MAYALAGU, K. 1983. Influence of different soil amendments on the physical properties of a heavy black soil and yield of groundnut. TMV-7 in the Periyar Vaigai command area. *Madras agric. J.* **70** : 304-308.
- NAGARAJAN, R., MANICKAM, T. S., KOTHANDARAMAN, G. V., RAMASWAMY, K., and PALANISWAMY, G. V. 1985. Manurial value of coir pith. *Madras agric. J.* **72** : 533-535.
- NAGARAJAN, R., SAVITHRI, P., SUBBIAH, S., KALAIMANI, S. and ANDRAN, D. J. 1991. Effect of continuous application of coir pith on yield, availability and uptake of nutrients in alfisol. In: *Proceedings of seminar on Utilization of coir pith in agriculture*. 20th Nov. 1991, Tamil Nadu Agricultural University, Coimbatore. pp. 9-16.
- NAGARAJAN, R., RAMASWAMY K., SAVITHRI, P. and MANICKAM, T. S. 1984. *Bulletin "Coir waste in crop production"*. Tamil Nadu Agricultural University. 39 p.
- NAGARAJAN, S. 1983. Retting of coconut husk. *Coir* **27** (1) : 5-6.
- NAMBIAR, C. K. B., HAMEED KHAN, H., JOSHI, O.P. and PILLAI, N. G. 1983. A rational approach to the management of coastal sands for establishment and production of coconuts. *J. Plantn Crops* **11** (1) : 24-32.

- PAVITHRAN, C. 1993. Possibility of using coconut pith as a matrix for controlled/slow release systems in agriculture. In: Workshop on utilization of coir pith - papers presented 13 Feb. Pollachi. Coir Board, Govt. of India, Cochin.
- PILLAI, K. S. and WARRIER, N. S. 1952. Coconut pith as an insulating material. *Indian Cocon. J.* 5 (4) 157, 159-161.
- RAJENDRAN, P. 1991. Evaluation of coir waste and farmyard manure in different forms and method of application in rainfed cotton based inter cropping system and their residual effect on sorghum. Ph.D Thesis, Tamil Nadu Agricultural University, Coimbatore.
- RAMAMOORTHY, S., CHELLAMUTHU, S., LAKSHMINARASIMHAN, C. R., RAJAMANNAR, A., and SUBRAMANIAN, V., 1991. Studies on the effect of composted coir pith and gypsum on the yield of irrigated groundnut in salt affected soil. In: *Proceedings of seminar on 'Utilization of coir pith in Agriculture'*. 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore, pp. 136-150.
- RAMASWAMY, P. P. 1989. Efficient utilisation of coir waste. *Tamil Nadu Agric. Univ. Newsl.* 11 : 4.
- RAMASWAMY, P. P. and KOTHANDARAMAN, G. V. 1991. Drought management using agri-industrial wastes. In: *Proceedings of seminar on 'Utilization of coir pith in agriculture'* 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore pp. 83-89.
- RAMASWAMY, P. P. and T. T. N. SON. 1993. Enrichment of coir waste with micro and macro nutrients. In: National Seminar on Developments in Soil Science. Abstracts, pp. 66-67. Indian Society of Soil Science, New Delhi.
- RAVICHANDRAN, B. C. 1988. Evaluation of decomposed coir pith on the grain yield of maize. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Bangalore. p.
- SAMPSON, H. C. 1923. *The Coconut Palm, The Science and Practice of Coconut Cultivation*. John Bale, Sons & Damelsson Ltd. London, 262 p.
- SANTHIRASEGARAM, K. 1965. 'Dry dust' from coconut fibre mills. A useful soil ameliorant. *Ceylon Cocon. Quart.* 16 : 85-98.
- SATYANARAYANA, K. G., MOHANDAS, P. N., PILLAI, C. K. S. and PAVITHRAN, C. 1984. Characteristic action and utilization of coconut tree based materials. *Indian Cocon J.* 14 : 18.
- SAVITHRI, P. and RANI PERUMAL. 1993. Use of poultry dropping enriched coir waste for inceptisol soils. In: National Seminar on Developments in Soil Science Abstracts : pp. 64, Indian Society of Soil Science, New Delhi.
- SAVITHRI, P., SUBBIAH, S., NAGARAJAN, R., MANI, S. and GOPALSWAMY, A., 1991. Effect of composted coir pith and gypsum applications on soil properties and yield of rice in sodic soil. In: *Proceedings of seminar on 'Utilization of coir pith in agriculture'* 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore. pp. 129-135.
- SAVITHRI, P., MURUGAPPAN, V. and NAGARAJAN, R. 1993. Possibility of economising potassium fertilization by composted coir pith application. *Fert. News* 38 : 39-40.
- SESHAREDDY, 1985. Enzymology of lignin degradation in coir dust by *Pleurotus sajor caju*. M.Sc. (Ag) Thesis, Tamil Nadu Agricultural University, Coimbatore.

- SINGARAM, P. and POTHIRAJ, P. 1991. Coir pith an amendment for tannery polluted soils. In: *Proceedings of the seminar on 'Utilization of coir pith in agriculture'* 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore. pp. 118-121.
- SMITH J. I. and ELLIOTT, L. F. 1990. Fillage residue management effects in soil organic matter dynamics in semi-arid region *Adv. Soil Sci.* **73** : 69-88.
- SUNDERSINGH, S. D., RAMIAH, S., PURUSHOTHAMAN, S. and RAJAGOPAL, A. 1991. Effect of irrigation regimes methods of irrigation and coir pith application on sugarcane yield. In: *Proceedings of seminar on 'Utilization of coir pith in agriculture'*, 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore. pp. 65-72.
- THAMBIRAJAH, J. J., and KUTHUBUTHEEN, N. J. 1989. Composting of palm press fibre. *Biological Wastes* **27** : 257-269.
- THERADIMANI, M. and MARIMUTHU T. 1993. Role of native microflora in decomposing coir pith. *Indian Cocon. J.* **24** : 5-6.
- UTHIAH, B. C., INDIRESH, K. M., and PRABHAKARA SHETTY, T. K. 1993. Preliminary studies in the effect of mulches and irrigation in growth of young coconut plants in coastal Karnataka. *Indian Cocon. J.* **24** (6) : 5-9.
- VEERABADRAN, V. 1991. Coir pith application and yield of rainfed millets in red soil. In: *Proceedings of seminar on 'Utilization of coir pith in agriculture'* 20th Nov. 1991. Tamil Nadu Agricultural University, Coimbatore. pp. 91-99.